

# USAISEC

*US Army Information Systems Engineering Command*  
*Fort Huachuca, AZ 85613-5300*

2

U.S. ARMY INSTITUTE FOR RESEARCH  
IN MANAGEMENT INFORMATION,  
COMMUNICATIONS, AND COMPUTER SCIENCES

**AD-A268 686**

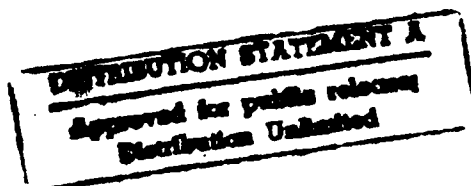


## ANNUAL HISTORICAL REVIEW FISCAL YEAR 1989

**1 OCTOBER 1988 - 30 SEPTEMBER 1989**

(ASQB-G-90-007)

January 1990



**AIRMICS**  
**115 O'Keefe Building**  
**Georgia Institute of Technology**  
**Atlanta, GA 30332-0800**



**93 8 26 045**

**93-20017**

U.S. ARMY INSTITUTE FOR RESEARCH IN  
MANAGEMENT INFORMATION,  
COMMUNICATIONS, AND COMPUTER SCIENCES  
ANNUAL HISTORICAL REVIEW

(RCS CHIS-6 [R3])

FISCAL YEAR 1989

1 October 1988 - 30 September 1989

Prepared by  
LTC James T. Blake  
Deputy Director  
10 January 1990

## EXECUTIVE SUMMARY

Fiscal year 1989 was a banner year for AIRMICS. Our research received international recognition, our projects produced significant results, and we exceeded the DA obligation rate goal. USAISC also authorized personnel resources to fill our newly formed Technology Insertion Division, and we completed 75% of its staffing. We augmented our researchers with subject matter experts from several universities, including scientists from Historically Black Colleges and Universities (HBCUs), and participated in the DA Intern Program and the ROTC Cooperative Program. Our involvement with HBCUs is quite pro-active. In terms of percentage of contract dollars, we did four times better than the DA average. Also, using the same percentage comparison, we did six times better than the DA average for contacts with small businesses.

AIRMICS has a broad research mission. It covers the entire Information Mission Area (IMA). To manage this mission, we have partitioned our program into six research areas -- Distributed Systems, Software Engineering, Communications and Networks, Very Large Databases, Decision Support, and Management of Information. While our resources do not permit us to embark on major projects in all of the research areas, we still maintain some level of effort in each of these through cooperative efforts with other government agencies or through participation in university-based research centers.

International recognition came to AIRMICS this year. Our personnel presented papers at internationally recognized conferences and several papers were either accepted for or appeared in highly refereed, leading international research journals. Our presentations to NATO on Information Centers (ICs) were well received, and NATO is going to use our research as a foundation for the formation of NATO Information Centers.

This makes the second year that AIRMICS has executed a research program in excess of five million dollars. We did this by attracting funds for IMA-related research from other Army organizations. Our portion of the FY 1989 RDTE appropriations was approximately two million dollars, so sixty percent of our research funds came from such organizations as DISC4, OTEA, and LABCOM. This attests to the quality and utility of our research and to the need for continuing IMA-related research and development.

Significant accomplishments were made in the twenty-four research projects which were executed in FY 1989, and these are summarized in Chapter II, SIGNIFICANT ACTIVITIES. Of course, the accomplishments are the direct result of the most important asset of AIRMICS; the engineers, scientists, and administrative personnel who execute and manage these projects. Two-thirds of our total staff have advanced degrees and several more are actively pursuing masters degrees.

Fiscal year 1989 was a good one for AIRMICS, and next year we plan on improving on our achievements.

  
John R. Mitchell  
Director, AIRMICS

## PREFACE

This Annual Historical Review (AHR), prepared in accordance with the provisions of AR 870-5, Military History: Responsibilities, Policies, and Procedures, covers the major activities of the U.S. Army Institute for Research in Management Information, Communications, and Computer Sciences (AIRMICS) for Fiscal Year 1989.

*James T. Blake*  
James T. Blake  
LTC, AV

Accession For	
NTIS GRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification <i>per form 50</i>	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
<i>A-1</i>	

DTIC QUALITY INSPECTED 3

# TABLE OF CONTENTS

	Page
EXECUTIVE SUMMARY .....	i
PREFACE .....	ii
TABLE OF CONTENTS .....	iii

## CHAPTER

I	INTRODUCTION	
	A. Mission Statement .....	1
	B. Key Personnel .....	1
	C. Organizational Chart .....	1
	D. Strength Figures .....	2
	E. Dollar Resources .....	2
II	SIGNIFICANT ACTIVITIES	
	A. Leveraging Our Resources .....	3
	B. Small Business Innovation Research (SBIR) .....	4
	C. Visiting Scholars and Research Associates Program .....	4
	D. Independent Research and Development (IR&D) .....	5
	E. Workshop Activity and PM Support .....	5
	F. Software Test and Evaluation Panel (STEP) .....	6
	G. Pilot Video Teleconferencing (VTC) Network .....	6
	H. Integrated Services Digital Network (ISDN) .....	7
	I. Harmonization of DOD Standards .....	7
	J. Ada-Related Research .....	7
	K. Ada Programming Support Environment .....	8
	L. Improving Operational Test and Evaluation .....	8
	M. Software Maintenance Issues .....	9
	N. Information Centers (ICs) .....	9
	O. Group Decision Support Systems (GDSS) .....	9
	P. Executive Information Systems (EIS) .....	10
	Q. Development of an Executive Management System .....	10
	R. Research in Distributed Systems .....	10
	S. Design of an Adaptable Distributed System .....	11
	T. Database Research .....	11
	U. Parallel and Distributed Systems .....	12
	V. Numerical Electromagnetics Code (NEC) Enhancement .....	12
	W. Multimedia Network Design Study .....	13
	X. Message Handling System in the Post 2000 Era .....	13

## Chapter I

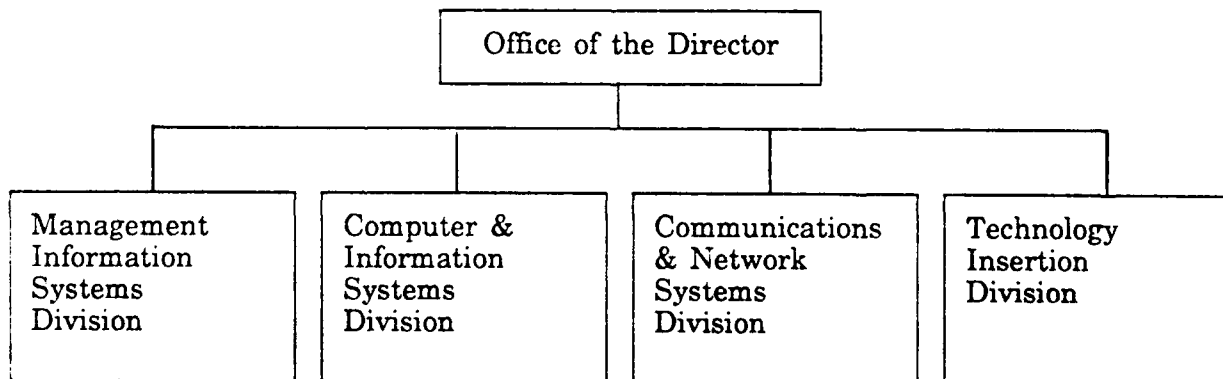
### INTRODUCTION

A. *Mission Statement.* Conduct and sponsor applied research in the areas of telecommunications, automation, visual information, records management, and printing and publications systems which address Information Mission Area needs.

B. *Key Personnel.*

TITLE/INCUMBENT	INCUMBENCY
DIRECTOR, AIRMICS	
Mr. John R. Mitchell, GM-15	12 May 1985 - Present
DEPUTY DIRECTOR	
LTC James T. Blake	16 June 1988 - Present
RESOURCE MANAGER	
Mrs. Randa Sharman, GS-11	5 May 1986 - 13 January 1989
Mrs. Patsy A. Riley, GS-11	13 March 1989 - Present
CHIEF, MANAGEMENT INFORMATION SYSTEMS DIVISION	
Dr. James D. Gantt, GM-14	1 October 1985 - Present
CHIEF, COMPUTER & INFORMATION SYSTEMS DIVISION	
Mr. Glenn E. Racine, GM-14	4 August 1987 - Present
CHIEF, COMMUNICATIONS & NETWORK SYSTEMS DIVISION	
Dr. C. Ronald Green, GM-14	4 August 1987 - 31 March 1989
Dr. John W. Gowens, GM-14	18 September 1989 - Present
CHIEF, TECHNOLOGY INSERTION DIVISION	
LTC James T. Blake	1 October 1988 - Present

C. *Organizational Chart.*



# D. *Strength Figures.*

	OFF	WO	ENL	CIV	INTERN	OH	TOTAL
Begin FY 1989							
AUTH	6	0	0	15	3	0	24
REQ	6	0	0	26	0	0	32
ASG	5	0	0	13	1	0	19
End FY 1989							
AUTH	6	0	0	19	2	0	27
REQ	7	0	0	30	0	0	37
ASG	5	0	0	16	2	0	23

E. *Dollar Resources.* In addition to the normal appropriation of RDTE funds, AIRMICS received additional funds from various government agencies to conduct joint research and development (R&D) projects. DA funding was also provided for two DA Interns, three ROTC Cooperative Program students, and one full time person to support the Historically Black Colleges and Universities (HBCU) Research Program. Our funding for FY 1989 can be summarized as follows (amounts are in thousands of dollars):

RDTE		
PE62783A (Project DY10)		2218.0
Funds from other government agencies:		
Department of the Army for HBCU		66.0
Office of the Secretary of the Army (Artificial Intelligence Center)		168.4
Personnel Command		160.0
Director for Information Systems, Command, Control, Communications, and Computers		784.8
Forces Command		188.4
Army Materiel Command		526.0
Operational Test and Evaluation Agency		110.0
Training and Doctrine Command		150.0
Laboratory Command		587.9
Center for Signal Warfare		36.0
Army Signal Center		144.9
		-----
	SUBTOTAL	5141.0
OMA		
P39		122.7
P81 ROTC Cooperative Program		22.5
P87 INTERN Program		31.0
P95 HBCU		63.8
		-----
	TOTAL	5381.0

## Chapter II

### SIGNIFICANT ACTIVITIES

#### *A. Leveraging Our Resources.*

AIRMICS is a member of several university-based, academia-industry-government research centers, and we are an affiliate of the Software Engineering Institute (SEI). This year we were active in the SEI, the Software Engineering Research Center (SERC), the Center for Innovation Management Studies (CIMS), and the Center for Information Management Research (CIMR). In addition to these centers, we have also laid the ground work for joining the Center for Telecommunications Research (CTR) on 1 October 1989.

We are particularly excited about the CIMR since we co-founded this center in FY 1989 with the National Science Foundation (NSF) under their Industry-University Cooperative Research Program. The expansion of the AIRMICS' research mission to include the entire Information Mission Area (IMA) created the need to cover new technology areas. Our membership in the CIMR will help us address these areas. The CIMR will link the Information Management Program at the University of Arizona with the Information Engineering Program at the Georgia Institute of Technology and create an Information Systems Design Program. The center will focus on: 1) determining ways to enhance information systems support of organizational goals, objectives, and strategies, 2) promoting the development of information systems designs which focus on the resources and needs of diverse organizational environments, 3) promoting the integration of advanced information technologies with traditional information systems, 4) developing a framework for management of information systems resources which is consistent with the organization's management systems, and 5) encouraging the identification and development of a portfolio of information products and services. Membership in the CIMR consists of AIRMICS, NSF, and seven corporations. Members of the center pool their monies to execute a significant research program. By sponsoring this center, AIRMICS is able to influence the direction of research conducted by the CIMR.

The SERC is co-located at Purdue and the University of Florida, and our membership in the SERC works the same as with the CIMR. AIRMICS' relationship with the SERC is indicative of the benefits that accrue to members of the various centers. Our affiliation with SERC enabled us to locate and contract with experts in the software engineering field. For example, the Harmonization of DOD Standards Project and the evaluation of the Distributed Computing Design System (DCDS) sponsored by DISC4, both reported on in this AHR, are being performed by members of the SERC. New projects in the areas of debugging, requirements definition, and design format translation are planned for FY 1990.

AIRMICS is also an affiliate of the Software Engineering Institute at Carnegie Mellon University. This year we began executing a plan to implement SEI's assessment program within ISEC. The assessment program is a formalized process to evaluate an organization's software engineering capabilities and needs and should be of benefit to ISEC in determining where we stand in terms of capability to address current and future software development and maintenance support. A team was formed and received training in September at the SEI. The assessment of Software Development Center-Washington (SDC-W) is scheduled for February 1990.



### *B. Small Business Innovation Research (SBIR).*

Over the past several years, AIRMICS has been providing funds to a pool of money used by DOD to enhance scientific research and development in the private sector. This year we began an active role in this program known as the DOD Small Business Innovation Research (SBIR) Program. The DOD SBIR program strives to stimulate technological innovation in the private sector; thereby, strengthening the role of small business in meeting DOD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DOD-supported research and development results in areas selected by the DOD components. The program has three phases, and the first two are funded with SBIR funds. Successful projects can receive approximately \$50,000 in the first phase and up to \$500,000 in the second phase.

In FY 1989, AIRMICS had two projects approved for inclusion in the Phase I solicitation, and we are proud to announce that contracts were awarded for both projects. The two projects are entitled: "An Environment for Simulation Modeling of Distributed Systems" and "Decision Making in a Geographically Distributed Environment." Phase I for these two projects will be completed in early 1990, and indications are that at least one of these projects will be SBIR-funded in Phase II. AIRMICS also had two projects incorporated into the FY 1990 Phase I solicitation. It is important to note that all these SBIR projects are directly related to the IMA, and hence ISC, yet we are able to compete Army-wide and receive funding for these proposals from LABCOM.

### *C. Visiting Scholars and Research Associates Programs.*

The research associates program is designed to supplement the AIRMICS staff with other government employees or faculty from universities who address short-term projects of interest to the Army. Nine of the individuals performed their work at AIRMICS and two performed their research at their duty assignments. Four of the people were Army officers, one a DOD civilian, and six from local universities.

AIRMICS has capitalized on several personnel programs and the research resources at Georgia Tech. Through the use of the Intergovernmental Personnel Act, the Laboratory Cooperative Research Program, and the Summer Employment for Historically Black College Professors Program, we were able to sponsor several researchers from HBCUs along with researchers from other institutions.

Dr. Robert Bozeman and Mr. Harvey Giddens, professors at Morehouse University, worked with us in assessing and evaluating CASE technology, tools, and design approaches for an in-house research project on transitioning STAMIS to Ada. They also presented a seminar at AIRMICS on object-oriented versus functional decomposition designs.

Dr. Solomon Fesseha, from Morris Brown College, and Ms. Kathryn Scanlon, from the Defense Systems Management College, conducted research on the status of the Army's library system and published a report for the Army Library Management Office of DISC4. The report looked at information technology and interoperability issues for Army libraries.

Dr. Jerome Wiest, from Georgia Tech (on leave from the University of Utah), worked on an evaluation of project management packages. He also supervised the work done

on the Army Standard Information Management System (ASIMS) Utilization Study conducted by Captains Pete DeFluri and Jerry Harbison, Army graduate students at Georgia Tech. Their work identified numerous questions dealing with utilization growth and provided insight into potential cost-saving measures for the future. Their work was favorably received at the 7th Signal Command, the study's sponsor, and this project is being continued as an in-house project in cooperation with DCSOPS 7th Signal Command.

Dr. Catherine Beise, from West Georgia College, worked on methods for improving the distribution of information developed by AIRMICS. She also assisted in the ASIMS Utilization Study and the Library Management Project.

Dr. Jim Hooper, from the University of Alabama at Huntsville, completed a four month stay at AIRMICS in January as a visiting scientist. Dr. Hooper completed a study and wrote a paper on software reuse entitled *A Perspective of Software Reuse*. His work supported the reuse research we conducted for DISC4 which is detailed elsewhere in this AHR.

Finally, MAJ Robert Averett, 201st Signal Support Company, Korea, and MAJ Mitch Marovitz, the US Military Academy, both conducted research sponsored by AIRMICS at their duty assignments which related to the IMA. MAJ Averett is looking at decision making among senior Army leaders, and MAJ Marovitz is looking at factors influencing the acceptance of new information technologies into organizations.

#### *D. Independent Research and Development (IR&D).*

This is our third year with management responsibility for USAISC's IR&D Program. Our review of corporate IR&D programs for this year shows that IMA-related research is being performed in software engineering, communications, distributed systems, and information management. During FY 1989, AIRMICS completed evaluation of 1415 projects from 33 companies. The total dollar value of these projects was \$769 million. Two hundred of these projects were ISC/IMA related, and reports on 30 of these projects were forwarded to ISC-DCSPLANS for dissemination to interested organizations in ISC. Organizations who have particular interest in IR&D projects can, and are encouraged to, participate in on-site reviews of these companies' programs. This aspect of the IR&D Program is particularly important since it provides ISC a window into non-governmental research that can potentially benefit the IMA. AIRMICS devotes a significant amount of effort in screening corporate IR&D for ISC to identify those projects that have the potential for exploitation and high payoff. We encourage ISC activities to attend on-site reviews so that the command can capitalize on this effort.

#### *E. Workshop Activity and PM Support.*

We made significant contributions to two high-level workshops, and we also began assistance to the Program Manager for Installation Support Modules (PM-ISM).

At the Ada 9X Workshop in May 1989, we presented the concerns of ISC/ISEC in regard to the upcoming revision of the Ada language. We specifically addressed Ada enhancements that would benefit information systems that ISEC must develop and support for the Army community. Our continued participation in these workshops is essential to ensure that changes to Ada help, rather than hinder, our software development centers.

We briefed and are providing input to the Defense Acquisition Board, Science and Technology Committee, Software Technology Working Group. The purpose of this group is to produce a DOD-wide Software Technology Master Plan to define a program by which DOD can provide increasing capabilities for emerging and existing systems while at the same time reducing the costs and logistics burden associated with development and life cycle maintenance of software. The plan will be completed by summer 1990, and we intend to maintain an active role in the development of this plan.

During FY 1989, we began providing assistance to PM-ISM. He has a vision of tomorrow's sustaining base support requirements, and we are helping him ensure that in the 90's he fields support modules with 90's technology instead of out-dated technology. Our Group Decision Support Systems' research is also of great interest to him.

#### *F. Software Test and Evaluation Panel (STEP).*

In 1981, OSD began a series of research projects aimed at improving the software development process and at establishing better control of the test and evaluation of DOD software products. In 1983, AIRMICS joined the effort, and by 1985, provided recommendations to OSD for implementation. As a result of this effort, OSD changed its policy on software test and evaluation and issued DOD Manual 5000.3-M-3. For whatever reasons, no further implementation action was taken. Now, in 1989, we are participating in a DA-level effort aimed at the same problem identified in 1981. AIRMICS is a member of the newly established STEP, and we are looking forward to helping DA to get software costs under control.

#### *G. Pilot Video Teleconferencing (VTC) Network.*

Last year, with the support of the Army Secretariat, we began a project with Historically Black Colleges and Universities (HBCUs) to look at video teleconferencing. During FY 1988, we established two VTC sites -- Clark Atlanta University and Fort Huachuca. We made great strides in FY 1989 in the conduct of this research. Specifically, we added an additional site (Fort Belvoir) to the VTC network that we established last year, and we shifted to a more cost-effective and readily available transmission medium. This project is focusing on the uses, costs, and benefits of low-cost, full-motion, two-way, non-secure VTC as applied to Army problems. The obvious benefits of this technology have generated significant interest in this project from DOD, other federal agencies, and the other services.

This VTC network is providing links between Army sites and HBCUs to improve campus relations and increase research interaction and student recruitment. Next year six additional sites will be added -- three universities (Prairie View A&M, Howard University, and North Carolina A&T) and three Army locations. These additional sites will allow increased interaction with the HBCUs for research and will improve campus relations. Also during FY 1989, Clark Atlanta University produced a 10 minute video tape which describes the project in detail; it has received wide distribution. Our initial VTC network required satellite links for communication, but this year we were able to obtain the needed bandwidth via fiber optic links. So we have made the changeover and now use all fiber communications links. The change to fiber has greatly reduced the initial per unit installation costs of the system, and it has extended the connectivity of the network to several hundred commercial organizations.

#### *H. Integrated Services Digital Network (ISDN).*

Throughout the Army, changes are occurring in automation and the exchange of information. The Army has identified ISDN as the objective configuration to support and manage this flow of information. In FY 1988, AIRMICS began a research project to examine application issues associated with the Army's use of this technology. OSD and DCA have expressed interest in this project, and the lessons learned from our research will help DCA with their planned research efforts.

During FY 1989, AIRMICS continued its research by beginning research in the installation, analysis, and simulation of future communications and networking components of ISDN. We also began to assemble an applications research test bed for ISDN applications. With this test bed, AIRMICS will develop techniques and procedures to quantitatively measure and evaluate the performance characteristics of the emerging ISDN services. We expect the test bed to be operational by April 1990. During FY 1990, depending on funding constraints, we plan to compare ISDN services to other existing services at a level of detail which will allow users to determine their required services based on their applications.

#### *I. Harmonization of DOD Standards.*

For several years, there has been some inconsistency in the documentation requirements needed and used by the development community and the information systems software support organizations. The most recent version of DOD-STD-2167 added to the confusion. This year AIRMICS was asked by ISSC-TSD to look at this problem. We executed a short-term task that addressed the harmonization of DOD-STD-2167A (Defense Systems Software Development) and DOD-STD-7935A (DOD Automated Information Systems Documentation Standard). The result was a guidelines document that takes advantage of the software engineering and management approaches embodied in 2167A while maintaining the use of documentation items associated with 7935A. This will assist the PEO/PM community in developing the necessary documentation to support new information systems software at the Software Development Centers that is compliant with both standards.

#### *J. Ada-Related Research.*

We had two Ada-related research projects in progress this year. Our Ada Reuse effort completed its last full year, with a final report due in March 1990, and we began a project with Software Development Center-Atlanta to examine the implications of transitioning STAMIS from COBOL to Ada. The use of standardized components has greatly reduced the complexity and hence the cost associated with building large hardware systems. What is needed is an equivalent approach in the software development environment.

Reusable program (Ada) modules are the equivalent of standardized hardware components. Our research effort looked at how to characterize a reusable module and what it takes to make reusability a viable concept from both a government and corporate perspective. The Ada Reuse Project examined metrics for Ada reuse, incentives for developers to embrace reuse, cost modeling for reuse efforts, and the suitability of software engineering tools. DISC4 has sponsored this research for several years. They gained considerable knowledge in the complexities of implementing reuse concepts and in how to approach policy issues associated with this development strategy. In FY 1990, we will publish the *Ada Reuse Guidebook* which will detail reuse employment concepts in program development environments.

AIRMICS Ada Transition Project is one of the Army's first attempts at porting a STAMIS from COBOL to Ada. The STAMIS we selected for this project is the Materiel Condition Status Reporting System (MCSRS) which contains 10,000 lines of COBOL statements. Although we are using MCSRS, the results of this research project will support all future STAMIS modernization efforts. We have three objectives in this effort: 1) re-engineer/restructure the existing COBOL application source code to obtain the systems requirements specification, 2) examine the relative merits of functional decomposition versus object-oriented design methods for STAMIS-like systems, 3) assess the potential benefits of applying CASE tools to redesign efforts. It is anticipated that the results of this work will be beneficial in transitioning older COBOL, flat file, and batch-oriented systems to interactive database systems written in Ada.

#### *K. Ada Programming Support Environment.*

There have been numerous reports critical of the quality of the Army's software and software support. To reduce these problems, DISC4 is considering specifying the Distributed Computing Design System (DCDS) as the Army's standard Ada Programming Support Environment (APSE). During this year, AIRMICS was asked to begin research to address the viability of this proposal. DCDS was developed by TRW for the Strategic Defense Command. DCDS is government-owned and supported, and it is operational at approximately 60 sites. It specifically supports large, complex, real-time distributed systems.

We are working with DISC4 and the Software Engineering Research Center at Purdue University to determine the suitability of DCDS as an APSE from an IMA perspective. We will compare DCDS with five of the leading CASE tools, determine what deficiencies, if any, that DCDS has based on published MIT and SEI programming support environment requirements, and report on whether it is appropriate to use DCDS as the Army's APSE. In FY 1990, we will finish this project and provide DISC4 an independent assessment of the validity of their proposal to standardize the software engineering development and support Environment with DCDS.

#### *L. Improving Operational Test and Evaluation.*

Over the last two decades, information systems software has been rapidly growing in size and complexity, and during this same time period, the reliance of military hardware on sophisticated software has increased, as well. As a result, obtaining valid operational testing of these information systems and military hardware has become very expensive. Therefore, the Army urgently needs a way to characterize the readiness of software for operational testing.

The Operational Test and Evaluation Agency (OTEA) desires a method for predicting when a system is ready for operational test so that fewer systems will fail a full operational test. In response to this need, OTEA is sponsoring research by AIRMICS and the University of Syracuse to develop a Reliability Prediction Method for Operational Testing Readiness. The objective is to develop a reliable method for predicting whether a system is ready for full-scale operational test prior to committing costly manpower and monetary resources for the conduct of such testing. We also want to be able to evaluate the outcome of such tests from a reliability perspective. This will increase the objectivity of the operational test results. We expect to complete our research in FY 1990, and we will provide a report detailing our results. When OTEA adopts the result of this project, it should save significant funds from false starts of

operational tests. Since OTEA has operational test responsibility for several STAMIS, the results of this research will have a bearing on ISEC.

#### *M. Software Maintenance Issues.*

Maintenance and support costs are widely recognized as the largest part of software's life cycle costs. In many cases, these costs exceed 80% of the total cost of a given software package. The Army is very concerned about the effectiveness of our software support organizations and the operational effectiveness of the software currently maintained by these organizations.

In the latter part of this fiscal year, DISC4 requested that we begin a research project to address these concerns. AIRMICS, in conjunction with the Center for Information Management Research, has already begun this effort. This project will accomplish three tasks: 1) develop a method to assess the effectiveness of a software support organization, 2) develop a method to assess the supportability of a fielded system, and 3) find measures to determine how well fielded systems can carry out their current missions. To ensure that the results of this research will immediately be useful to DISC4 and ISC, we are focusing on measures that are simple to apply and cost effective to implement.

#### *N. Information Centers (ICs).*

This year AIRMICS has continued to assist the Army in the implementation of Information Centers world-wide. Our contributions this year include the publication of a second guidebook and the generation of NATO interest in ICs. Since 1985 the Army has implemented over 400 ICs at various levels within the Army. The initial mission of most Army ICs was to serve as the point of contact for automation-related issues. Currently, the IC mission is expanding to become the single point of contact for all IMA-related problems. The initial AIRMICS research focused on the planning and implementation of ICs which supported automation issues. This work resulted in the publication of a guide on the planning and implementation of ICs. During FY 1989, an additional guidebook entitled *IMA Integration Guidebook* was completed. This guidebook provides suggestions to Directors of Information Management (DOIMs) on how to migrate the IC from a single discipline focus to one that addresses all five disciplines of the IMA. This research has supported the efforts of ISC-DCSPLANS and 7th Signal Command-DCSOPS, and the guidebook was distributed to all DOIMs during FY 1989. Our second effort this year was devoted to promulgating the concept of ICs to other nations. This will contribute to better interoperability of systems between allies and will improve command and control. In this regard, AIRMICS made two presentations to the Information Systems Working Group of NATO. They subsequently decided to use the results of our research in the implementation of ICs within NATO.

#### *O. Group Decision Support Systems (GDSS).*

Most information applications have addressed either the needs of the organization or of individuals acting independently; however, there is a growing realization that groups or teams of people have unique information requirements that warrant special attention. One particular technology that addresses these needs is Group Decision Support Systems.

AIRMICS has been conducting research in several projects that look at different aspects of GDSS. One report completed in FY 1989 looked at electronic meeting systems and their potential application to military systems. This work, which was funded by the

Defense Systems Management College (DSMC), presented a framework to classify GDSS and reviewed the major applications currently available. Another project, done by the University of Arizona, looked mainly at decision rooms for support groups. This research is now moving toward distributing the group room tools over a local area network. The move toward distribution of the GDSS tools is strong and was the main focus of two other efforts. Georgia Tech and Spelman College looked at distributed teams and how various information technologies impact the decision process. The results of this effort which will be available in FY 1990 will provide guidelines to developers of GDSS in a distributed environment. The last project was funded under the SBIR program. The work done by Analytical Software, Inc. focused on geographically distributed GDSS. This effort uses commercial communications links and provides users with simple to use GDSS tools which allow them to interact within a group of people who are working together on specific projects. The fact that the group participants may be on different networks and may be using different computing systems is transparent to them. The results of our research in GDSS will be of significant benefit to Army managers. In fact PM-ISM is currently looking at applications within the acquisition environment.

#### *P. Executive Information Systems (EIS).*

Since FY 1987, AIRMICS has been supporting the Program Manager, Acquisition Information Management (AIM), in the development of an EIS which will improve the Army Acquisition Executive's (AAE) ability to provide oversight of the acquisition process and refine the voluminous data available to assist in the decision making process. Last year we developed a prototype system, and this year we refined and improved the prototype, demonstrated a common data architecture, developed a training program, and designed and developed software for importing existing data into this system. The project is scheduled for completion in FY 1990. The results of this project will be of immediate benefit to the acquisition management structure (AAE, PEOs and PMs), and the principles demonstrated will also have applicability in many other Army management environments.

#### *Q. Development of an Executive Management System.*

Within the executive levels of the Army, there is a growing need for portable communications equipment that provides error-free remote data access into mainstream communications channels. This will allow Army leaders to maintain communications and coordinate operations from remote locations. To identify the concepts and requirements for an executive management system that can provide this capability, PEO & Strategic Information Systems (SIS) selected the Electronic Portable Information Center (EPIC) manufactured by ANALYTICS of Fairfax, VA, as a prototype for evaluation. The EPIC is a laptop computer with hard disk, full-featured cellular telephone, and Hayes compatible modem contained within a briefcase. Using the EPIC as a prototype, evaluations of this new voice-data terminal technology are being performed to develop applications for this technology which can be transferred to the Army senior executive level. AIRMICS began this project in FY 1989 and most of the evaluations and testing by senior-level Army executives have been completed. In December 1989, a final report on the results of our evaluations and our appraisal of the benefits of this technology will be provided to PEO-SIS.

#### *R. Research in Distributed Systems.*

Implementation of distributed systems will effect changes in the areas of "automation of information" and "the exchange of information between sustaining bases" within the

Army. A distributed system can allow the sharing of large resources (e.g., databases) in an effective manner, but the manner in which the processes or load is allocated to the interconnected resources will affect the performance of the applications. Given a computer network and applications, how do we distribute the load in such a way that we achieve some acceptable level of performance? This is a tough question in a dynamic environment, and one that must be answered if the Army is to make efficient use of its computing resources.

At AIRMICS, we are up to the challenge. This year we began a three-year project with the University of Southern California to develop mathematical models and simulation tools that address the many aspects of this problem. Given a hardware configuration, these tools will enable us to evaluate and improve the performance of a distributed system. The tools will permit the modeling of applications, performance evaluation, load balancing (static and dynamic), and reconfiguration to improve system performance.

#### *S. Design of an Adaptable Distributed System.*

Last year AIRMICS and NASA, Langley Research Center, continued a project to develop prototype tools for the design and development of distributed systems. These tools will be capable of incorporating new distributed systems technology as it becomes available. We also hope to gain some insight into techniques for improving database reliability, improving access to multiple databases located at different locations, operating with heterogeneous databases, and maintaining current information throughout the system. We are currently using a tool being developed at Purdue University called the Robust, Adaptability, and Intelligence in Distributed Database (RAID) System. Its development and implementation are planned for completion by the summer of 1991. A current software version of the RAID system has been installed in the AIRMICS computer laboratory for on-site evaluation, demonstration, and determination of needed enhancements. An enhanced user interface, operating system, and communications system will be designed to improve overall system performance. The results from this research will greatly assist the Army in its efforts to build and maintain an interactive, geographically-dispersed, dynamic information system.

#### *T. Database Research.*

In FY 1988, we began a three-year research effort to help the Army gain control over the multitude of databases and their component data elements that exist in today's information systems. At that time, we developed the concept of an "encyclopedia" for managing databases. This year, we developed a prototype. This project has created a great deal of interest from DISC4 and ISC organizations, and its future looks promising. The encyclopedia embodies the Army Information Model. It will accommodate changes and represent security requirements in the model.

The encyclopedia provides the means to organize, manage, and access Army metadata (information that describes data) which are essential to achieve synchronization of data values as well as interoperability and integration among Army information systems. The current prototype includes a database registration module, schema integrator, browser, and IRDS-compliant repository. (The Information Resource Dictionary System is a National Institute of Standards and Technology sponsored standard.) Current work involves integrating these modules under X-windows, developing a graphical interface for the schema integrator, and developing AI-based tools to assist in the generation of standard data element names. Future efforts will include research and development in query formulation for a distributed environment and distributed query processing.



#### *U. Parallel and Distributed Systems.*

The Army, like today's modern corporations, is moving toward distributed processing to handle information processing requirements. The efficiency of distributed environments is a function of the architecture, applications, and control structure which comprise the entire system. At present, there is no one tool or single technique for looking at the tradeoffs associated with competing system designs. There are techniques to look at the efficiency of different parallel or distributed architectures. There are also tools which can evaluate applications in a given implementation. But the integration of both architecture and applications is not available. The Army needs the capability to evaluate competing systems in their entirety. We need a tool to analyze and to simulate competing proposals because building several systems and then choosing a particular system from among them using benchmark programs is too expensive an approach.

AIRMICS has started research to build such a tool. This is a three-year effort in coordination with the University of California at Berkeley. The approach is to extend the Berkeley Requirement Statement Language (BRSL) to address the hardware components of a parallel or distributed system. BRSL already addresses the applications aspects of a distributed computing environment; the extension will add the capability to specify the processors and the interconnection network for an integrated system. By April 1990, we will have completed a survey of existing approaches to hardware and software modeling with an eye on incorporating the positive aspects of existing tools.

In the next phase of the effort, AIRMICS will develop a set of prototype parallel architecture modeling tools which can be used to evaluate the performance of specific applications on available parallel machines or environments. The results of this research will aid the Army by providing methods for developing more efficient parallel processing environments through simulation. In addition, results from the simulation will provide feedback to the distributed software design process, enabling the user to analyze the entire software and hardware system.

#### *V. Numerical Electromagnetics Code (NEC) Enhancement.*

The introduction of 32-bit personnel computers (PCs) has greatly increased the computational power available on an engineer's desk top. The capability of these PCs makes it feasible to port many mainframe applications to a PC environment. One such application ready for porting to a PC environment is an antenna modeling program called NEC. NEC was originally developed at Lawrence Livermore National Laboratory, and it is used extensively throughout DOD. It requires complex numerical integrations and manipulates very large matrices to solve the required antenna design equations.

The desire of design engineers within ISEC to have NEC available on a PC has sparked our interest in satisfying their need. We have already begun work on porting the NEC code to an 80386-based PC environment. The original mainframe-resident NEC program contains 10,000 lines of Fortran code within 80 subroutines. We plan to port this code to a PC, resolve any numerical instabilities associated with the PC-based math coprocessor chips, and benchmark the performance of the ported code. Then, we will restructure the code to facilitate future maintenance activities. The second phase of this project will consist of identifying the graphical interface requirements needed for engineers to more effectively use this powerful and versatile design tool. The final phase of this project will be the integration of the graphical interface, both for the

input and output requirements, with the revised code and a final analysis of the effectiveness of implementing NEC with an upgraded I/O interface.

#### *W. Multimedia Network Design Study.*

Due to the increasing need for efficient interconnection of communications systems such as DDN, DSN, AUTOVON, and post or local area networks, analysis tools must be developed to evaluate an entire system, not just individual nodes within the system. Therefore, this project will provide new analysis tools and techniques specifically developed for the analysis of multimedia, multimission networks. Multimedia networks may incorporate such transmission media as coaxial cable, fiber optics, and twisted pair, and a mission may involve such activities as making a set of financial transactions or conducting a teleconference.

AIRMICS has begun research which focuses on the optimization of media selection relative to traffic types and the performance measurement of multimedia, multimission networks. We have already completed a survey of the Army strategic network and plans and developed a taxonomy of the media and traffic types. From this data, a prototype steady-state network model was completed. Next fiscal year, we will add adaptive routing, flow control, and network management algorithms on a representative network model and develop network performance and mission-oriented metrics.

#### *X. Message Handling System in the Post 2000 Era.*

An important aspect of ISC's responsibility for providing telecommunications support to the Army is providing the linkage between tactical and sustaining base communications. An important consideration in planning for this support is the interoperability of US communications with those of our allies. AIRMICS is sponsoring research, in coordination with the Signal Center at Fort Gordon, to examine the message handling functions of networks so as to determine the terminal capabilities that will be required in NATO in the year 2000 and beyond. While the area of concern is ten years away, it is not too early to look at these requirements. After all, most military systems take five to ten years to field and these systems remain operational for twenty or more years. The focus of this research is to assess future requirements. This will help determine the capabilities that new equipment and upgrades must have in order to ensure that US and NATO acquisitions move toward an integrated system. This research directly supports the mission of ISC, and it is in consonance with the NATO Tactical Communications Post-2000 Memorandum of Understanding (TCP 2000 MOU). The results of this study will also help to identify the interface requirements between the tactical message handling system and the Defense Message System. We plan to complete the final report in the first quarter of FY 1990.